AVIONICS SIMULATION, DEVELOPMENT AND SOFTWARE ENGINEERING

FINAL REPORT

March 7, 2002

Sponsored By:

GEORGE C. MARSHALL SPACE FLIGHT CENTER

MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Under:

Contract No. NAS8-00114

Purchase Order No. H-32832D, Express Rack Software Support

bd Systems, Inc.
Monthly Technical Progress Report
Contract No. NAS8-00114
Purchase Order No. H-32832D, Task Order 2
International Space Station (ISS)
Expedite the Process of Experiments to Space Station (EXPRESS) Racks Software Support
Reporting Period: August 10, 2000 to March 1, 2002

Review of Work Accomplished

During this reporting period, all technical responsibilities were accomplished as planned. A close working relationship was maintained with personnel of the MSFC Avionics Department Software Group (ED14), the MSFC EXPRESS Project Office (FD31), and the Huntsville Boeing Company. Accomplishments included: performing special tasks; supporting SRB, ATB, and ESCP activities; participating in technical meetings; and coordinating issues between the Boeing Company and the MSFC Project Office.

Special Tasks

Several special tasks were completed during this reporting period.

- A software end-to-end process description that was initiated by FD31 was completed by bd Systems. This description starts with requirements and continues throughout the development and on-orbit usage. This plan was presented to the ESCP and comments were incorporated.

- bd Systems participated in the development of the charter for the MSFC EXPRESS Software Control Panel (ESCP). The ESCP panel began functioning in February of 2001 and meets weekly.

- Participated in an analysis of how the Boeing Company is developing the flight software for the EXPRESS Racks and to provide a recommendation whether or not an Independent Assessment (IA) or an Independent Verification and Validation (IV&V) of the software is needed. The proposed appendix to NPG 2820 was used as the criteria for the analysis. The results of the analysis indicate that the criteria for IA and IV&V are not approached. ED14 and FD31 agreed that IA and IV&V are not needed.

- Coordinated activities with the MSFC Avionics Department's EEE parts Group (ED16), to determine cost information for an electrical switch that is to be used on EXPRESS ground racks. Personnel of ED16 responded in a timely manner by contacting the vendor and getting price quotes for quantities of 1 each and 100 each. This information was passed on to the EXPRESS Project Office (FD31).

- bd systems located special video test equipment owned by MSFC that could potentially be loaned to Boeing. The equipment was located and FD31 and Boeing were notified of the MSFC equipment owner.

- Participated in problem resolution of the qualification B-RIC for the Biological Research Project (BRP). Participated in the Test Readiness Reviews (TRRs) at the Wildwood Electronics Incorporation, near the Jetplex. The TRRs were held to review the test plans for the continuation of the regression tests required to complete the qualification of the B-RIC.

- The quick-look report for the HRF regression testing of sustaining software release 2A was reviewed. The report indicates that the software performed as planned without any problems, and is ready to be loaded into the on-orbit HRF1 rack when desired.

- Performed a review of the BRP SSPCM First Article of Inspection (FAI). Twenty-three documents were reviewed and comments were provided to the MSFC BRP Project Office (FD31). The comments included: typographical errors, missing appendices, missing data, contradictions in verification methods of requirements, inadequate documentation of the GIDEP program, and questionable rational for accepting the usage of EEE parts that have a stress ratio greater than unity. A recommendation was made to the MSFC BRP Project Office (FD31) to request that ED10 experts review the EEE parts that have a stress ratio greater than unity.

- Engineering Change Proposal (ECP) BE01256 was reviewed. This ECP updates the labeling format for the WORF rack and cables. Additionally, the WORF Laptop display software will be updated to reflect the new labels. The ECP accurately describes the software modifications to be made and a recommendation was made to approve the ECP as written.

- Coordinated concerns and issues, that Boeing had with the C-RIC sustaining software task, with the Marshall project office.

- Participated in a series of Boeing presentations of HHR software development and testing plans and re-plans. Collected and distributed HHR documentation that will be used by a MSFC led audit team to access the HHR software development and testing plans.

On-Orbit Support Activities

During this reporting period, support was provided for several activities that led to the transporting to the ISS and operation of four EXPRESS racks, and one Human Research Facility (HRF) rack. Numerous software anomalies were encountered with the EXPRESS racks resulting in several rack "reboots". A "tiger team" was formed to investigate these anomalies. Team members included personnel from MSFC, Boeing-Huntsville, Teledyne Brown, and bd Systems. The anomalies included, heartbeat counter not incrementing, loss of rack health and status telemetry, loss of science telemetry, and processor "lock up". The investigation resulted in the development of a new Sustaining Software Release 2 (SR2) to correct four problems: interrupt handler, 1553 device driver for Lance chip, payload discrete handler, and conflicting memory block allocations. SR2 has been loaded on three of the EXPRESS racks and is performing as designed. Future software releases are planned to correct other known problems. The on-orbit sequence of events are as follows:

- EXPRESS Rack 1 (ER1) was activated on 4-24-2001.

- Human Research Facility 1 (HRF1) rack was activated on 5-18-2001.

- EXPRESS Rack 2 (ER2) was activated on 5-24-2001.
- EXPRESS Rack 5 (ER5) was installed into ISS on 8-14-2001, but not activated.
- EXPRESS Rack 4 (ER4) was activated on 8-21-2001.
- EXPRESS Rack 1 (ER1) was loaded with Software Release 2 on 9-07-2001.
- EXPRESS Rack 2 (ER2) was loaded with Software Release 2 on 9-19-2001.
- EXPRESS Rack 4 (ER4) was loaded with Software Release 2 on 10-24-2001.

SRB Activities

During this reporting period, bd Systems personnel participated in Boeing's Software Review Board (SRB) meetings. Software Problem Reports (SPRs), software build activities, software load requests, and the schedule of events for the PSIVF, RSTB, and ATB were discussed and dispositioned by the SRB. Activities accomplished during this reporting period are:

- Coordinated with Boeing to obtain accounts to the SPR database for MSFC project personnel.
- Planning the development and testing of the initial and sustaining CSCIs for the HRF, EXPRESS, and WORF racks.
- Planning the investigation of anomalies encountered during on-orbit operations.
- Planning the development of software flight products for dedicated payload configurations.
- Planning the development and testing of the CSCI for the BRP HHR rack.
- Planning the scheduling of events to support testing of the B-RIC Test-Set with the Q-RIC, B-RIC, and FEU-RIC.

RSTB Activities

Participated in the reviews of the development plans for the Rack Software Test Bed (RSTB).
Participated in the scheduling of the development of software for the Habitant Holding Rack (HHR).

PSIVF Activities

A summary of PSIVF activities that were performed is as follows:

- Participated in reviews leading to the certification of the PSIVF per the 50K contract requirements.
- Participated in reviews for the testing of software flight products for dedicated rack configurations.

- Participated in the planning of investigation activities of on-orbit anomalies as documented by Payload Anomaly Reports (PARs).

- Participated in the planning of the RIC characterization testing.

- Reviewed the PSIVF activities relating to the testing of the Sustaining Software Release 1B (automatic load of rack subset ID at boot-up), for the 8/2 EXPRESS Rack (Non ARIS).

- Coordinated and participated in a meeting with personnel form MSFC ED14, MSFC QS10, bd Systems, and Defense Contract Management Agency (DCMA) to discuss Boeing's proposal to change the PSIVF SQA and S&MA oversight functions. The current oversight system is hardware orientated and is cumbersome for software functions. The proposed oversight system utilizes Boeing SQA, DCMA, and new processes/procedures developed for the PSIFV environment. The consensus opinion formulated at the meeting is that the new oversight system should involve Boeing SQA and DCMA during events leading up to the test (Test Readiness Review, review of Test Procedures, etc.), during the test, and during post test activities (review of test results, test problems and resolutions, and test reports); and the new oversight system should be properly documented in the PSIVF Operations Manual and the S&MA Plan. This opinion was given to Boeing and to the MSFC Project Office.

TIM Support

A two-day TIM (Technical Interchange Meeting) at MSFC was attended to discuss MSFC, JSC, KSC, and Boeing processes and responsibilities in the delivery, test, and integration of flight software. Attendees included personnel from bd Systems, Boeing-Huntsville, MSFC, JSC, KSC, and Teledyne Brown Engineering (TBE). Several teleconferences were subsequently participated in to continue the discussion. The discussion topics included:

- Software deliveries.

- Software change process.

- Software Quality Assurance (SQA) Support for On-Line and Off-Line activities.

- Software functions delegated to KSC SQA.

- GSE Laptop certification guidelines.

- Letter of Delegation (LOD) for KSC S&MA coverage of software activities at KSC.

- Define the On-Orbit Load Repository Process for the RIC Software.

- Define the Process for Planned and Emergency Updates for On-Orbit Software.

Review of topics and comments were provided to the appropriate organizations.

ATB Activities

A review of ATB activities to support development and testing of flight CSCIs was conducted and appropriate comments were provided during this reporting period. These activities include the following:

- Development and regression testing of the EXPRESS 8/2 with ARIS CSCI.
- Development and regression testing of the EXPRESS 8/2 without ARIS CSCI.
- Development and regression testing of the HRF CSCI.
- Development and formal acceptance testing for the WORF software.

One significant event was detected and reported to the MSFC project office. A requirement was imposed upon Boeing to deliver the software code on Compact Disks (CDs) instead of Floppy Disks. Boeing did not have plans to convert the HRF software into the CD format. After the MSFC project office was made aware of the situation, Boeing was directed to develop and test HRF software in the CD format.

ESCP Activities

The MSFC EXPRESS Software Control Panel (ESCP) was attended and supported during this period. Several tasks were performed in support of these activities.

- bd systems coordinated the request to gain access to Boeing's SPR database on a personal computer and the ESCP conference room computer.
- An Excel spreadsheet was developed to track SPRs. This spreadsheet provides a status of SPRs reviewed by the ESCP and provides reference information of related SPRs, type of software, type of hardware, MSFC operational notes, and KSC problem reports.
- The Boeing Software Problem Report (SPR) database was accessed several times at the request of MSFC project office, and the requested information was provided.
- A review of plans, studies, and documents was conducted which includes the following:
  - RIC characterization testing.
  - Software auto load trade study.
  - Implementation plan for sustaining SPRs.
  - Payload Integrated Flight Load (PIFL) document.
  - CSCI test plans.

Meetings Support
During this reporting period, several meetings were supported and include the following:

- Boeing to MSFC Program Management Reviews.
- MSFC EXPRESS team meetings to review/work issues relating to upcoming flight activities.
- Supported the JSC Payload Software Control Panel (PSCP) via teleconference. The PSCP controls the Payload Experiment Processor (PEP) software and the Payload Operation and Integration Center (POIC) ground databases for the EXPRESS project.
- Supported meetings to discuss the development of the Rack Software Test Bed (RSTB).
- Test Readiness Reviews (TRRs) for the sustaining CSCIs.
- ED14 bi-weekly group meetings.
- ED14 monthly EXPRESS project reviews.
- FD31 weekly group meetings.
- Supported meetings to discuss on-orbit operational anomalies.
- Supported meetings to discuss the testing of DCPCG in the PSIVF.
- Supported a series of meeting to discuss the testing of the BRP HHR CSCIs. A Function Qualification Test (FQT) will be derived from the informal test. A subsequent meeting within FD31 was attended to discuss a request for an independent requirements audit by ED10.
- Attended the HHR quarterly review that was held at MSFC. All responsible parties agreed upon the latest FQT approach for the software testing during the review (MSFC Project Office, MSFC Software, ARC Project Office, Boeing Software, and Boeing Project Office).
- Supported a meeting to discuss Boeing's integrated schedule approach. This schedule is to include all tasks relating to the 50K contract, available manpower to perform the tasks, and all facilities/equipment available to support the tasks.
- Supported a meeting with DCMA and the software code designer to discuss SPRs relating to the EXPRESS and BRP Suitcase Simulators (ScS). The issues discussed in the meeting were discussed with the Project Office (FD31) in a follow-on meeting.
- Supported Test Readiness Reviews (TRRs) for the B-RIC qualification test.

EXPRESS Workbook
A workbook was developed to provide concise information about EXPRESS hardware/software and its derivatives. This workbook is formatted with the Microsoft Excel software. Subjects/topics are

arranged by "Excel Sheets" and include personnel names, acronyms, descriptions of development facilities, hardware and software deliverables, rack assignments for flights, and planned flight dates.

Other

Received mandatory training classes in person and by the Internet.

- The yearly training on MSFC's Information Technology was performed. This training teaches correct procedures and practices to maintain proper integrity of computer systems, and the transferring of data between computer systems via local networks and the Internet.
- A safety training class titled "Performance Evaluation Profile" was attended.
- Attended a meeting for bd Systems personnel stationed at MSFC. A mandatory safety video "Slips, Trips, and Falls" was viewed.
- The bd Systems "Discrimination and Harassment" training was completed.

Acronyms

ARIS	Active Rack Isolation System
ATB	Avionics Test Bed
B-RIC	Biological Research Project Rack Interface Controller
CD(s)	Compact Disc(s)
COTR	Contracting Officers Technical Representative
CSCI(s)	Computer Software Configuration Item(s)
CWC(s)	Collaborative Work Commitment(s)
DCMA	Defense Contract Management Agency
DCPCG	Dynamically Controlled Protein Crystal Growth (UAB Experiment)
ECP	Engineering Change Proposal
ER(s)	EXPRESS Rack(s)
ESCP	EXPRESS Software Control Panel
EXPRESS	Expedite the Process of Experiments to Space Station
FAI	First Article Inspection
FEU(s)	Functional Equivalent Unit(s)
FQT	Functional Qualification Testing
GSE	Ground Support Equipment
HHR	Habitant Holding Rack
HRDL	High Rate Data Link
HRF	Human Research Facility
IA	Independent Assessment
ID	Identification
IPR(s)	Interim Problem Report(s)
ISS	International Space Station
IT	Information Technology
IV&V	Independent Verification and Validation
JSC	Johnson Space Center
KSC	Kennedy Space Center
LOD	Letter of Delegation
MSFC	Marshall Space Flight Center
NASDA	National Aerospace Development Agency of Japan
NC	Non Compliant
ON(s)	Operations Note(s)
OPMS	On-Line Project Management System (Oracle database)
ORD	Operational Readiness Date
PAR(s)	Payload Anomaly Report(s)
PEP	Payload Experiment Processor
PEP	Performance Evaluation Profile
PIFL	Payload Integrated Flight Load
POIC	Payload Operations & Integration Center
PR(s)	Problem Report(s)
PSCP	Payload Software Control Panel
PSIVF	Payload Software Integration & Verification Facility
RIC(s)	Rack Interface Controller(s)
RSTB	Rack Software Test Bed
S&MA	Safety & Mission Assurance
SPR(s)	Software Problem Report(s)
SQA	Software Quality Assurance
SRB	Software Review Board
SSPCM(s)	Solid State Power Control Module(s)
TBD	To Be Determined
TBE	Teledyne Brown Engineering
TCP/IP	Transport Control Protocol/Internet Protocol
TIM	Technical Interchange Meeting
TRR	Test Readiness Review
UF	Unified Flight
WEI	Wildwood Electronics Inc.
WORF	Window Observation Research Rack